



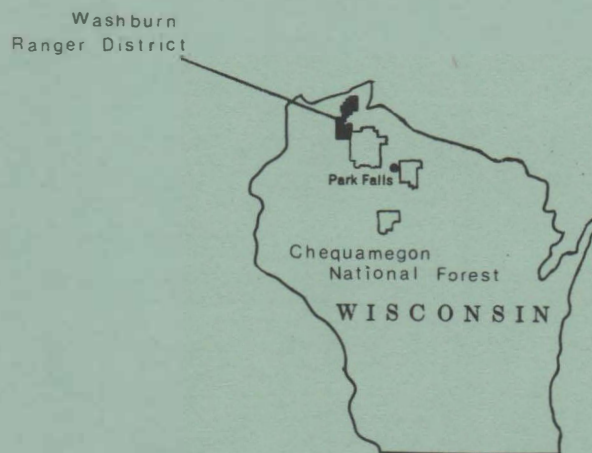
Forest Insect & Disease Management

Evaluation
Report

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JACK PINE MORTALITY
WASHBURN RANGER DISTRICT
CHEQUAMEGON NATIONAL FOREST, WISCONSIN



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ABSTRACT

An evaluation was conducted in northern Wisconsin during 1975 to determine causes of death of 30 to 40 year old jack pine (Pinus banksiana Lamb) trees. An average of 22% of trees were dead per area surveyed with the majority of the mortality occurring from 1972-73. The onset of the mortality happened approximately 4 years after the stands were defoliated by the jack pine budworm. Armillaria mellea was found to be the major cause of death after the trees were stressed by the jack pine budworm, eastern gall rust, sweetfern rust and drought.

INTRODUCTION

During 1975 the Chequamegon National Forest staff identified an abnormally high rate of mortality (up to 30%) in 30 to 40 year-old jack (Pinus banksiana) stands 15 miles north of Ashland, Wisconsin. The agent was suspected to be eastern gall rust caused by Cronartium quercuum (Berk) Miyabe. A preliminary evaluation of the stands revealed the presence of eastern gall rust; sweetfern blister rust, caused by Cronartium comptoniae Arth.; Armillaria root rot, caused by Armillaria mellea (Vahl) Quel.; and previous jack pine budworm defoliation, caused by Choristoneura pinus Freeman. Eastern gall rust is reported to form galls on limbs and main stems of jack pine. The galls cause limb death, weaken the stems, and make them subject to wind damage (2). Sweetfern blister rust reduces the growth rate and may cause death of the host (1,5). Armillaria root rot lives as a saprophyte on dead wood and commonly attacks trees weakened by insects, diseases, injuries and adverse environmental conditions (4). The jack pine budworm causes twig mortality, reduces tree growth for 2 or more years after defoliation and commonly causes top kill. Tree mortality occurs under heavy defoliation and is more common when the outbreak coincides with additional stress such as drought (3).

OBJECTIVE

The objectives of the survey were to determine the extent of past and present tree mortality and its causal agents and to predict future mortality.

MATERIALS AND METHODS

The Chequamegon National Forest staff identified 15 areas for evaluation. Each area consisted of a jack pine stand or a cluster of adjacent stands separated only by roads and trails. The survey consisted of examination of 100 trees per area on one transect run across the planted rows. One tree was sampled in each row. In areas with several stands, transects, each with 25, 33, or 50 trees, were located in each stand.

The data for each tree were collected during June and July 1975, as follows:

1. Size class - d.b.h. and crown class
2. Tree condition - live, dying, dead
3. Time of death - estimation
 - a. 1974 - red foliage present
 - b. 1973, 1972 - no foliage, but fine twigs present
 - c. 1971 & earlier - no fine twigs
4. Presence of armillaria, sweetfern rust, and eastern gall rust on the main stem.

RESULTS

The data in Table 1 show that an average of about 22% of trees per area surveyed were dead. Most of these trees, an average of 18%, died during the period of 1972-73, thus resulting in an average annual death rate of about 9%. Before then, only 3.0% of trees were dead, perhaps over a 5 year period. The current mortality (1974) is an average of about 2%.

The greatest average mortality per area surveyed, 78%, was among suppressed trees, while an average 36% of intermediates were dead. Only an average 4% of dominant trees were dead.

The comparison of disease incidence on live and dead trees (Table 2) shows that armillaria root rot was present on an average 86% of dead trees per area surveyed, but on only an average 2.1% of live trees. Gall rust was found on an average 41.0% of live trees and 45% of dead trees. Sweetfern rust was present on an average 6% of live trees and 12% of dead trees.

Data in Table 3 show the relationship between disease incidence and frequency of tree mortality. Of 648 trees with gall rust, 22% were dead. Sweetfern rust was present on 110 trees, of which 36% were dead. Armillaria root rot was present on 310 trees and 90% of those were dead.

Comparison of causes of mortality for periods of 1971 to 1973 and 1974 to 1975 show similar patterns (Table 4)

One of the major causes of mortality appears to be breakage of the trunk (Table 4). Although the 1971 and 1973 trees had higher percentage of broken trees, we suspect that more of them could have been dead from other causes and then broken as a result of decay. About 15 percent of the standing dead trees had armillaria root rot as the only apparent cause of death (Table 4) in 1972-73. A quarter of the standing dead trees had trunk galls or abundance of branch galls as a potential stress factor. Of these, about half of the trees dying in 1974 and 1975 had armillaria and nearly all the trees that died in 1971 to 1973 had armillaria. Of all the 1974-75 dying trees, cause of death cannot be established for 8 percent.

DISCUSSION

Armillaria root rot was the most prevalent disease on the dead jack pine. Various stress factors favor this disease, which may enter after the upper part of the tree has died. However, 50% of dying trees (1975) and 70% of recently killed trees (1974) already had armillaria, and of these latter, armillaria was the only apparent cause of death on 14% of the dead trees. We conclude that armillaria was one of the primary mortality factors in these stands. Since the percentage of armillaria increased with years from tree death, not all cases of armillaria may have been detected with the method used, as it may have entered on the dying trees. We conclude that armillaria was both a primary killer of weakened trees and an invader of dying trees. Most of the trees killed by sweetfern rust also had armillaria. Most of the broken trees had armillaria, although some were broken before being infected. Presence of gall rust appeared to provide sufficient stress for the trees to become susceptible to armillaria. Finally, tree competition itself appears to favor armillaria, since most of the trees without other causes of death were in the suppressed and intermediate crown class.

About half of all the dead trees were broken. The larger percentage of broken trees from 1971 to 1973 period suggests that many cases of breakage may have occurred after death of the tree. Gall rust appeared to weaken some of the trees, but about half of the broken trees in 1974 and 1975 did not break at the gall. Heavy snow and ice in spring of 1975 apparently caused most of this breakage.

The causes of mortality in the 1971 and 1974 trees and 1974 and 1975 trees appeared to be similar, but, the frequencies of mortality were different. Much of the area was moderately to heavily defoliated by the jack pine budworm. Usually, during budworm outbreaks some trees are heavily defoliated, and tree mortality between 5 and 10% is common. The smaller crown trees, suppressed and intermediates, are killed more frequently than the dominant trees. Thus, the mortality increase during 1971-73 can be attributed to the jack pine budworm outbreak. In addition, a severe drought during the summer of 1969 probably intensified the stress, and the trees succumbed to armillaria root rot. Current annual tree mortality rate is about 2% and can be expected to continue until the next major stress period.

RECOMMENDATION

The following silvicultural considerations may help to prevent serious losses in the future:

1. Increase age and species variation of pine in the area to reduce budworm outbreak hazards.
2. Harvest heavily defoliated stands as soon as possible.
3. Plant non-susceptible species in areas of high sweetfern rust incidence.

Literature Cited

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Table 1. Summary of jack pine mortality, Washburn R.D., Chequamegon N.F., 1971 or earlier to 1974. Percentage of trees dead and estimated year of death.

Area No.	Compartment and Stands	Total Mortality	Year of Death		
			1974-75	1972-73	Before 1972
1	212-8,14	12	4*	7	1
2	163-3	9	5*	2	2
3	153-2,9	32	3	24	5
	146-3				
4	225-4	13	1	11	1
5	222-4				
	224-1,16	26	2	14	10
6	205-22				
	185-3	33	1	28	4
7	222-1,3	26	3	23	0
8	221-15	25	1	19	5
9	221-21	27	0	22	5
10	222-3,6	30	1	27	2
11	209-1,2,3,4				
	220-1,2				
	221-19	29	1	28	0
	218-9,15				
12	204-5,2,3,8	16	0	16	0
13	208-7,9	21	1	17	0
14	205-19				
	207-9	17	0	15	2
15	210-13,15				
	211-5,13,15	19	1	18	0
Average		22.3	1.6	18.1	2.7

* Evidence of recent fire.

Table 2. Disease incidence in living and dead trees and intensity of defoliation by jack pine budworm, Washburn R.D., Chequamegon N.F., 1972 to 1974 (in percent).

Sample Area	Live Trees				Dead Trees				Budworm Defoliation	
	Total	ARR*	GR	SFR	Total	ARR	GR	SFR	1967	1968
1	88	1	35	1	12	67	58	8	M	
2	91	2	41	1	9	67	56	11		M
3	68	6	54	1	32	84	50	12		M
4	87	5	44	19	13	92	54	46	M	M
5	74	1	23	19	26	88	27	19	M	M
6	67	3	48	10	33	79	55	3		M
7	74	3	31	1	26	100	42	4	M	
8	75	1	35	12	25	88	32	4	M	
9	73	3	47	8	27	89	44	26	H	
10	70	1	33	1	30	87	37	0		M
11	71	1	48	1	29	86	62	7	H	
12	84	2	44	6	16	94	38	0		M
13	79	1	48	6	21	90	43	5	M	
14	83	1	35	7	17	82	29	18	M	
15	81	1	49	2	19	89	47	11	M	
Average	77.7	2.1	41.0	6.3	22.3	85.5	44.9	11.6		

*CODES: ARR-Armillaria; GR-Gall rust; SFR-Sweetfern rust; M-Medium; H-Heavy

Table 3. Association of jack pine mortality and disease incidence, Washburn R.D., Chequamegon N.F.

Area of Survey	Type of Disease					
	Armillaria		Main Stem Gall Rust		Sweetfern Rust	
	Total No.	Dead %	Total No.	Dead %	Total No.	Dead %
1	9	89	38	18	1	0
2	8	75	42	12	2	50
3	31	87	53	30	5	80
4	16	75	45	16	20	30
5	24	96	34	21	19	26
6	28	93	50	36	8	12
7	28	93	34	32	2	50
8	23	96	34	24	11	18
9	26	92	46	26	13	54
10	27	96	52	35	3	67
11	17	88	43	14	5	0
12	20	95	47	19	6	17
13	20	95	47	19	6	17
14	15	93	34	15	9	33
15	18	94	49	18	4	50
Total	310	--	648	--	114	--
Average		90.5		22.3		36.3

Table 4. Cause of jack pine mortality by year on all areas surveyed, Washburn R.D., Chequamegon N. F., 1975. (in percent).

Cause of Death	Year of Death	
	1974-5	1971-3
Broken Trunk		
At the gall rust	18	7
Otherwise	<u>22</u>	<u>48</u>
Total	40	55
No broken trunk		
Sweetfern rust	8	6
Armillaria only	14	15
Gall rust with armillaria	12	23
Gall rust without armillaria	16	2
No apparent cause	<u>8</u>	<u>0</u>
Total	58	46